

**What is claimed is:**

1. A packet transfer apparatus for a network system said apparatus comprising:  
a packet receiver that accepts an input of packets from a first network  
segment;  
a packet classifier that classifies packets based on their respective process  
flows;  
a packet discarder to discard packets;  
a packet sender that sends packets to a second network segment.

2. The apparatus of claim 1 wherein the network packet transfer unit is a router.
3. The apparatus of claim 1 wherein the network packet transfer unit is a switch.
4. The apparatus of claim 1 further capable of providing a unique process flow identification (PFID) to all packets belonging to a same process flow.
5. The apparatus of claim 4 further comprising a feedback mechanism between the packet discarder and the packet classifier.
6. The apparatus of claim 5 wherein the packet classifier can be provided information regarding discarded packets.

7. The apparatus of claim 6 wherein after receiving information about a discarded packet, the packet classifier stops transferring to a random early detector (RED) any further packets having the same PFID as that of the discarded packet.
8. The apparatus of claim 7 where only packets having the same PFID and a packet sequence number higher than a packet sequence number of the discarded packet are not transferred to the RED.
9. The apparatus of claim 7 capable of resuming sending packets upon detecting a retransmit of the discarded packet.
10. The apparatus of claim 9 wherein said detecting is based on the packet sequence number of the discarded packet.
11. The apparatus of claim 7 wherein the apparatus sends an acknowledgement packet, said acknowledgement being sent from a destination of the discarded packet to a source of the discarded packet, said acknowledgement containing a sequence number of the discarded packet.
12. The apparatus of claim 11 wherein said apparatus is capable of ignoring the acknowledgment packet.

13. The apparatus of claim 12 wherein the apparatus is capable of measuring an elapsed time between the discarding of the packet and a time immediately prior to receipt of the acknowledgment packet.
14. The apparatus of claim 13 wherein the apparatus is capable of setting a threshold time that is compared against the elapsed time.
15. The apparatus of claim 14 where the acknowledgment packet is not transferred when the time threshold is larger than the elapsed time.
16. The apparatus of claim 14 where the acknowledgment packet is transferred when the time threshold is equal to or smaller than the elapsed time.
17. The apparatus of claim 6 where upon receiving information of a discarded packet, only one more packet is sent to the RED, after which the process flow classifier ceases to transfer any further packets having the same PFID as that of the discarded packet.
18. The apparatus of claim 17 capable of resuming sending of packets upon detection of a retransmit of the discarded packet.
19. The apparatus of claim 18 capable of ignoring an acknowledgment packet transmitted from the destination to the source requesting the retransmit of the discarded packet.

20. The apparatus of claim 19 wherein the apparatus is capable of measuring an elapsed time between the discarding of the packet and a time immediately prior to receipt of the acknowledgment packet from the destination.
21. The apparatus of claim 20 wherein the apparatus is capable of setting a time threshold that is compared against the elapsed time.
22. The apparatus of claim 21 wherein a second packet is not transferred when the time threshold is larger than the elapsed time.
23. The apparatus of claim 21 wherein a second packet is transferred when the time threshold is equal to or smaller than the elapsed time.
24. The apparatus of claim 17 wherein the one more packet is a next immediately available packet having the same PFID.
25. The apparatus of claim 1 wherein early discard of packets is performed by randomly discarding packets.
26. The apparatus of claim 1 wherein early discard of packets is performed by a weighted random early discard technique.

27. The apparatus of claim 1 further capable of detecting an acknowledgment packet from the destination.
28. The apparatus of claim 27 further capable of identifying packets using their process flow identification (PFID).
29. The apparatus of claim 28 further capable of ceasing a transfer of packets having the same PFID.
30. The apparatus of claim 29 further capable of ceasing transfer of packets having the same PFID from a source to a destination.
31. The apparatus of claim 30 further capable of resuming transfer of packets with the same PFID when a retransmit request for the packet is detected.
32. The apparatus of claim 28 further capable of extracting a packet sequence number from the acknowledgment packet.
33. The apparatus of claim 32 further capable of ceasing transmission of packets from the source to the destination having the same PFID and a packet sequence number larger than that of the extracted packet sequence number.
34. The apparatus of claim 33 further capable of resuming transmission of packets with the same PFID when retransmit of the packet requested is detected.

35. A network system comprising:

a plurality of terminal nodes;

at least one packet transfer unit effectively connected between at least two of said terminal nodes;

said at least one transfer unit further comprising a packet classifier that classifies packets into their respective process flows.

36. The network system of claim 35 wherein the network packet transfer unit is a router.

37. The network system of claim 35 wherein the network packet transfer unit is a switch.

38. The packet transfer unit of claim 35 further capable of providing a unique process flow identification (PFID) to all packets belonging to a same process flow.

39. The network system of claim 38 further comprising a random early discarder (RED) of packets.

40. The network system of claim 39 further comprising a feedback mechanism between the RED and the packet classifier.

41. The network system of claim 40 wherein the packet classifier can be provided information regarding discarded packets.
42. The network system of claim 41 where after receiving information about a discarded packet, the packet classifier stops transferring to the RED any further packets having the same PFID as that of the discarded packet.
43. The network system of claim 42 where only packets having the same PFID and a packet sequence number higher than a packet sequence number of the discarded packet are not transferred to the RED.
44. The network system of claim 42 capable of resuming sending packets on detecting a retransmit of the discarded packet.
45. The network system of claim 44 wherein said detecting is based on the packet sequence number of the discarded packet.
46. The network system of claim 42 wherein the system sends an acknowledgement packet, said acknowledgement packet being sent from a destination of the discarded packet to a source of the discarded packet, said acknowledgement containing a sequence number of the discarded packet.
47. The network system of claim 46 wherein said system is capable of ignoring the acknowledgment packet.

48. The network system of claim 47 wherein the system is capable of measuring an elapsed time between the discarding of the packet and a time immediately prior to receipt of the acknowledgment packet.
49. The network system of claim 48 wherein the system is capable of setting a threshold time that is compared against the elapsed time.
50. The network system of claim 49 where the acknowledgment packet is not transferred when the threshold time is larger than the elapsed time.
51. The network system of claim 49 where the acknowledgment packet is transferred when the threshold time is equal to or smaller than the elapsed time.
52. The network system of claim 41 where upon receiving information of a discarded packet, only one more packet is sent to the RED, after which the packet flow classifier ceases to transfer any further packets having the same PFID as that of the discarded packet.
53. The network system of claim 52 capable of resuming sending of packets upon detection of retransmit of the discarded packet.



54. The network system of claim 53 capable of ignoring an acknowledgment packet transmitted from the destination to the source requesting the retransmit of the discarded packet.
55. The network system of claim 54 wherein the system is capable of measuring the elapsed time between the discarding of the packet and a time immediately prior to receipt of an acknowledgment packet from the destination.
56. The network system of claim 55 wherein the system is capable of setting a time threshold that is compared against the elapsed time.
57. The network system of claim 56 wherein a second packet is not transferred when the time threshold is larger than the elapsed time.
58. The network system of claim 56 wherein a second packet is transferred when the time threshold is equal to or smaller than the elapsed time.
59. The network system of claim 52 where the one more packet is a next immediately available packet having the same PFID.
60. The network system of claim 35 wherein early discard of packets is performed by randomly discarding packets.

61. The network system of claim 35 wherein early discard of packets is performed by a weighted random early discard technique.
62. The network system of claim 35 further capable of detecting an acknowledgment packet from the destination.
63. The network system of claim 62 further capable of identifying packets using their PFID.
64. The network system of claim 63 further capable of ceasing a transfer of packets having the same PFID.
65. The network system of claim 64 further capable of ceasing transfer of packets from a source to a destination having the same PFID.
66. The network system of claim 65 further capable of resuming transfer of packets with the same PFID when a retransmit request for the packet is detected.
67. The network system of claim 63 further capable of extracting a packet sequence number from the acknowledgment packet.

09747290-11200

68. The network system of claim 67 further capable of ceasing transmission of packets from the source to the destination having the same PFID and a packet sequence number larger than that of the extracted packet sequence number.

69. The network system of claim 68 further capable of resuming transmission of packets with the same PFID when retransmit of the packet requested is detected.

~~70.~~ A method of transferring packets in a network comprising:  
accepting an input of packets from a first network segment;  
classifying the packets based on their process flows;  
providing a unique process flow identification to packets belonging to a same process flow;  
discarding at least a packet;  
providing information to a packet classifier regarding the discarded packet;  
and  
stopping further transfer of packets having a same PFID as the discarded packet.

71. The method of claim 70 where only packets of the same PFID and a packet sequence number higher than a packet sequence number of the discarded packet are not transferred.

72. The method of claim 71 further comprising resuming sending packets on detecting a retransmit of the discarded packet.

73. The method of claim 72 wherein said detecting is based on the packet sequence number of the discarded packet.

74. The method of claim 71, further comprising sending an acknowledgement packet to the source of the discarded packet, said acknowledgement containing a sequence number of the discarded packet.

75. The method of claim 74, further comprising ignoring the acknowledgment packet transmitted from the destination to the source requesting the retransmit of the discarded packet.

76. The method of claim 75, further comprising measuring an elapsed time between the discard of the packet and a time immediately prior to receipt of the acknowledgment packet.

77. The method of claim 76 further comprising setting a threshold time that is compared against the elapsed time.

78. The method of claim 77, further comprising not transferring the acknowledgement packet when the time threshold is larger than the elapsed

05/26/2011 11:00 AM

- 36

84. The method of claim 70 further comprising detecting an acknowledgment packet from the destination.

85. The method of claim 85, further comprising identifying the packet using its PFID.

86. The method of claim 70 where random early discard (RED) is the method used for discarding a packet.

87. The method of claim 70 where weighted random early discard (WRED) is the method used for discarding a packet.